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ABSTRACT

The strength of intuitive knowledge is illustrated by the difficulty that individuals have in trying to restructure student misconceptions. In order to harness this power, intuition must be developed within the context of each new concept to be taught. An experiment with one possible approach to this instructional problem is described and evaluated. Fifty-nine elementary education majors were evenly divided into treatment and control groups. The treatment students received laboratory experiences of a sensory, feeling nature to stimulate development of intuitive understanding of basic concepts in physics. Post-test items were divided into three levels of complexity roughly following Blooms Taxonomy. Results of these tests were subjected to analysis of covariance and significant improvement in reasoning at the "comprehension" level of Blooms Taxonomy was discovered. (Author)

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IMPROVING REASONING THROUGH ENHANCEMENT OF PHYSICAL INTUITION

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The flood of research results coming from the study of student misconceptions has displayed, to a convincing degree, the inefficiency and in fact ineffectiveness of what we have been doing as teachers (Helm and Novak, 1983). Not that the present instructional system is hopeless; many of our students work hard, learn and understand, then go on to produce in the real world. The problem lies with the majority of the students who never seem to really "catch on". They are mystified, give up, turn off, and then the conceptual universe of the physical sciences is never accessible to them.

We can model the behavior of these lost students by regarding their minds as operating upon three levels. The ground level is best identified with the "gut center" of the student. This is the part of the person that feels, responds, wishes, intends, and otherwise confronts the world outside. This inner level of response controls the direction of energy to thought processes that run on the second level which is the "cognitive" level of deliberative thought. Operating on the cognitive level is known to the student as "hard work", doing the real job of learning and solving problems. Finally there is a third or superficial level where the student casually goes about the motions of appearing to learn. School activity is often found at such a level, largely a false world where you must play a game called learning. Years of schooling have taught students the

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proper script and they go through their lines without really "attending to" the process. In many classes, instructors can recognize these students by the dull, glazed eye and listless attitude.

Classical educational research spends most of its energy experimenting with the second level, arranging information and activities that require attention from the cognitive structure of the student. Since the operation of these second level skills depends upon personal choice, an exertion of energy directed from the inner "gut" person, the cognitive activities are not likely to be activated by an uninvolved student who is simply going through the motions.

On the other hand some students are very much involved with the task of learning but have such a paltry experience with the basics that understanding course content is a severe challenge. These students are not easily reached on the cognitive level because of the lack of backround information for them to grab onto.

Both of these two basic types of problem-students can probably be reached to advantage at the first or "gut" level. Any experience that is likely to "jab" the student at this "gut level" slips past the lack of preparation or lack of energy found on the cognitive level. Can these experiences have an effect upon cognitive functioning? Another way to frame the question is: do "right-brain" oriented experiences result in improved "left-brain" performance? Or one could ask: will reasoning improve if physical intuition is enhanced?

PROCEDURE

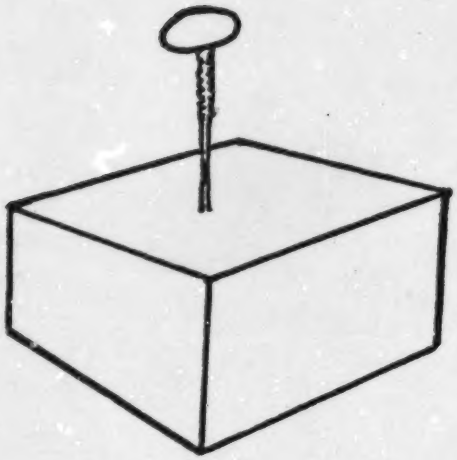
An experiment was conducted to search for evidence supporting an

answer to these common questions. Fifty nine elementary education majors were divided into a treatment and control group. The treatment group received special laboratory experiences intended to communicate in a non-verbal or nonsymbolic way to the inner, intuitive, center of the students first level. These experiences were prepared by following a simple little rule:

> Replace a measuring instrument
> with some portion of the sensory
> apparatus of the student.

This is a fancy way of saying that a student should be inserted within an experiment to feel or experience some aspect of the physical world. Such experiences are robbed of objective quantification; there will be nothing to calculate, no numbers to work with, but this also means that the cognitive level is relieved of its "burdens" (for the moment).

To give an example: the meaning of pressure can be developed by requiring a student to measure an area followed by division of that number into a measure of the weight that is sitting upon the area. Unfortunately the student fails to physically experience the meaning of pressure. For this study the treatment students were given a small block of wood that had one nail partially driven into one side.



They were asked to place the block upon their outstretched palm and feel the surface of the wood as it pressed against their palm. Then a 500 gram mass was slid onto the block so that the nail passed within the slot in the weight. Again the student had a chance to feel the result and compare the feeling with the one earlier without the weight. Finally the student was asked to turn the block of wood upside down, balance it on the palm of the hand with finger tips, and place the weight back onto the top surface of the block. The feeling of increased pressure as a result of area change is unmistakable.

In a different laboratory exercise, the conditions for equilibrium were explored using a meter stick balanced at the middle. Control students tried various weights at different distances to see how position of weights affects balance. The treatment students in addition to that replaced one of the weights with their hand. In this manner they felt the effect of moving weights back and forth along the meter stick. The treatment students also worked through exercises at estimating lengths, areas, volumes, and mass in order to encode these basic quantities into their intuitive level. They had a few other

feeling experiences with force and pressure and witnessed analogies with electrical circuits consisting of water flowing through glass tubes in series and parallel arrangements.

RESULTS

During treatment portions of the semester two main tests were given to the lecture class consisting of both treatment and control groups. The results of all questions from the two tests were combined into a single stratified score for each student. Three levels of test items were categorized from all questions. The first level represented factual recall items as identified by Bloom with the term "knowledge" in his Taxonomy (Bloom, 1956). The next level consisted of all test items requiring use of reasoning processes thus suggesting genuine comprehension of basic physical concepts. The third level of questions were those requiring considerable creative ingenuity for solving a problem that went beyond anything explicitly explained in the class or lecture. Performance on these three levels of test questions were compared for treatment and control groups.

COMPARISON OF TEST RESULTS FOR TREATMENT AND CONTROL GROUPS ALONG THE THREE LEVELS OF TEST ITEM COMPLEXITY

Group	Knowledge	Comprehension	Application
Control	91	68	31
Treatment	92	75	34

Numerical values in the table above present the percentage of test items at a particular level completed correctly.

An analysis of covariance was run on the data to find out if any differences between treatment and control were significant.

ANALYSIS OF COVARIANCE FOR TREATMENT AND CONTROL MEANS ACROSS THREE LEVELS OF REASONING COMPLEXITY

	Knowledge	Comprehension	Application
F Statistic	.66	2.01	.80
Probability	.51	.04	.42

The probability value is the likelihood that the control and treatment means are the same.

CONCLUSIONS

Elementary education majors are good at memorizing facts and fail at creative problem solving. Those who had the benefit of laboratory exercises aimed at developing their physical intuition demonstrated a small but significant superiority in apparent comprehension of physical concepts. Directing instructional experiences at the "gut feeling" level does pay off in stimulating higher order cognitive ability.

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ABSTRACT OF CONTRIBUTED PAPER PRESENTED

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Improving Reasoning Through Enhancement of Physical Intuition

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The strength of intuitive knowledge is illustrated by the difficulty that we have in trying to restructure student misconceptions. In order to harness this power, intuition must be developed within the context of each new concept to be taught. An experiment with one possible approach to this instructional problem is described and evaluated. Fifty nine elementary education majors were evenly divided into treatment and control groups. The treatment students received laboratory experiences of a sensory, feeling nature to stimulate development of intuitive understanding for basic concepts in physics. Post test items were divided into three levels of complexity roughly following Blooms Taxonomy. Results of the tests were subjected to analysis of covariance and significant improvement in reasoning at the "comprehension" level of Blooms taxonomy was discovered.

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